CHAPTER 3

METHODS

3.1 INTRODUCTION

The aim of this study was to obtain data on the floristic composition and structure of the plant communities that occur in the study area, as well as to compile a management plan for MNP.

3.2 AERIAL PHOTOGRAPH INTERPRETATION

For this study 250 x 250 mm black - and - white stereo aerial photographs were used, obtained from the office of the Surveyor General, Private Bag, Mowbray, 7705. The most recent photographs, namely Task 874 of 1984 on a scale of 1:50 000 were used. These stereo photographs were studied by using a stereoscope and homogeneous units were delineated on the basis of physiography and physiognomy (vegetation structure) (Bredenkamp & Theron 1978; Westfall 1981; Gertenbach 1987).

These homogeneous physiographic-physiognomic units were outlined and compared to one another and representative vegetation sampling was made in most of these units.

3.3 SAMPLING

3.3.1 Sample plot number

The number of sample plots is determined by the scale of the survey, the variation in the vegetation composition of the area and the accuracy required (Werger 1973; Gertenbach 1987). A total of 130 sample plots were surveyed throughout the study area. The number of sample plots for each delineated physiographic-physiognomic unit was determined according to the size of each delineated unit. The sampling intensity is one sample per 2,2 km².

3.3.2 Sample plot location

The sample plot location was determined by means of stratified-random sampling (Westfall 1981). The sample plots were distributed within the stratified physiographic- physiongnomic units over the entire study area (Gertenbach 1987).

The exact position of the sample plots was thus determined before hand and if it was found that a position was not homogeneous according to the survey requirements, the sample plot was moved subjectively to be more representative of the immediate vegetation and environment. This is according to Werger (1974), Coetzee (1975) and Gertenbach (1987) in accordance with the requirements for the traditional Braun-Blanquet-type of vegetation surveys. The position of a sample plot was only moved for the following reasons:

(i) If the sample plot was placed in an area where the vegetation was not homogeneous (Mueller-Dombois & Ellenberg 1974);

(ii) If the structure of the vegetation in the sample plot is not representative of the plant community (Werger 1974); and

(iii) If the sample plot was placed in disturbed areas such as gravelpits, roads and agricultural lands that were made after the photographs were taken.

Ecotones and obvious habitat and vegetation heterogeneity were avoided, as homogeneous vegetation is a prerequisite for sample plot location (Werger 1977; Gertenbach 1987). Thus to stratify and then to sample subjectively, the maximum data in reference to the vegetation were obtained.

Termitarium and riparian vegetation was not included in the placing of the sample plots. Separate sample plots were identified for the termitarium and riparian vegetation and sampling was done in these vegetation types.

3.2.3 Sample plot size and form

The minimal area of a sample plot was obtained by means of the species-area-curve (Coetzee & Werger 1975; Westfall 1981; Gertenbach 1987). For the purpose of this study a standard sample plot size of 10 m x 20 m was used throughout the study area, as this size exceded the minimum plot size. This size is also considered adequate for surveys in savanna vegetation by Coetzee (1975), Coetzee et al. (1976), Westfall (1981), Van Rooyen (1983) and Gertenbach (1987).

3.4 THE ZÜRICH-MONTPELLIER-APPROACH FOR THE CLASSIFICATION OF PLANT COMMUNITIES

The Zürich-Montpellier approach to the study of vegetation is commonly used in South Africa (Werger 1973; Coetzee et al. 1976; Bredenkamp & Theron 1978; Westfall 1981; Behr & Bredenkamp 1988; Du Preez et al. 1991; Kooij et al. 1992; Bezuidenhout 1993). The classification presented here is based on the Braun-Blanquet method of vegetation survey, discussed in detail by Westhoff & Van der Maarel (1973); Mueller-Dombois & Ellenberg (1974) and Werger (1974).

According to Westhoff & Van der Maarel (1973) and Gertenbach (1987) the basic principles of the Zürich-Montpellier approach can be summarised as follows:

a) Plant communities are recognized as vegetation units on the basis of their floristic composition. The complete floristic composition of a community gives a better reflection of the mutual alliances as well as the environment, than any other characteristic.

b) The species comprising the floristic composition of a plant community have certain mutual relationships. These species are called diagnostic or differential species.

c) These diagnostic species are used to organize communities in a hierarchical classification of which the association are the basic unit.

The definition of an association was adopted in 1910 at the Third International Botanical Congress in Brussels. A plant association is a "plant community of definite floristic composition, presenting a uniform physiognomy and growing in uniform habitat conditions" (Daubenmire 1968; Werger 1974; Gertenbach 1987).

In practice the Zürich-Montpellier approach consists of the following:

a) Sampling of selected, representative, homogeneous plots of a certain minimum size.

b) Recording all species and rating them on a cover-abundance and, optionally, a sociability scale.

c) Other analytical characters of the vegetation in the plot might also be recorded, such as density, production, etc.

d) The samples are entered in a table from which the vegetation units are extracted.

e) The composition, differentiation and characterization of associations (Werger 1974; Gertenbach 1987).

3.5 COVER-ABUNDANCE

At each sample plot a list is compiled of all the species occurring. A cover-abundance value is given to each species according to the cover-abundance scale, used by Braun-Blanquet and given by Mueller-Dombois & Ellenberg (1974) and Werger (1974).

5 - Any number of plants, with cover more than 75 percent of the sample plot.

4 - Any number of plants, with cover more than 50 to 75 percent of the sample plot.

3 - Any number of plants, with cover more than 25 to 50 percent of the sample plot.

2 - Any number of plants, with cover more than 5 to 25 percent of the sample plot.

1 - Numerous, with cover of 5 percent or less.

+ - Individuals with cover of less than 1 percent.

r - Usually a single individual with a cover of less than 1 percent.

According to Barkman et al. (1964) the definition of scale-unit 2 was too broad. Without altering the basic units, modifications were made by adding the following secondary symbols to the scale-unit:

2a - Covering between 5 and 12 percent of the sample plot area independent of abundance (indicated as A in the tables).

2b - Covering between 13 and 25 persent of the sample plot area independent of abundance (indicated as B in the tables).

The plant species in each sample plot were therefore evaluated according to a 8-point scale and not according to the traditional 7-point scale of Braun-Blanquet (Werger 1973; Gertenbach 1987).

3.6 VEGETATION STRUCTURE

3.6.1 Introduction

Dansereau (1957) defined vegetation structure as "the organization in space of the individuals that form a stand (and by extension a vegetation type or a plant association) and the primary elements of structure are growth-form, stratification and coverage".

The structural classification proposed here is independent of, but complementary to floristic, habitat and ecological classifications of vegetation (Edwards 1983).

Shimwell (1971); Mueller-Dombois & Ellenberg (1974) and Gertenbach (1987) divided vegetation structure into three categories viz.
a) Vertical structure (stratification into layers)
b) Horizontal structure (crown cover)
c) Quantitative structure (abundance of each species in the community).

The floristic composition as well as the vegetation structure are important components of a specific plant community (Gertenbach 1987). According to Westfall (1981) vegetation structure refers to the spacing and height of plants that forms the matrix of a vegetation cover.

Edwards (1983) used growth form, cover classes and height classes in his structural classification. The structural classification for this study was based on the broad-scale structural classification system of Edwards (1983).

3.6.2 Height classes

Vertical structure or stratification was determined in three height classes (Figure 3.2) viz.

a) Herbaceous stratum 0 - 1 m

b) Shrub stratum > 1 - 3 m

c) Tree stratum > 3 m

The first height class includes all the grasses and other forbs between 0 - 1 metres. The shrub stratum includes all single- and multi-stemmed woody vegetation between 1 m and 3 m. The tree stratum includes all single- and multi-stemmed woody vegetation higher than 3 m (Figure 3.2). The comparison of the height classes used in this study and the systems of Westfall (1981); Edwards (1983) and Gertenbach (1987) is given in Table 3.1.

3.6.3 Cover classes

Cover is defined as the vertical projection of the crown per height class (Mueller-Dombois & Ellenberg 1974; Edwards 1983; Gertenbach 1987). The crown: gap ratio used by Edwards (1983) and Gertenbach (1987) is a handy index to determine the percentage crown cover, and was used to determine the cover classes. According to Westfall (1981) the Domin-Krajina cover-abundance scale was considered more suitable for the veld condition assessment because of its greater detail, but it was not used in this study.

The cover classes for the different strata are as follows:

Cover	% Cover	Crown: Gap
Scattered	0,1 -1	> 30 - 8,5
Sparse	> 1 - 5	> 8,5 - 3,3
Open	> 5 - 10	> 3,3 - 2
Moderate	> 10 - 20	> 2 - 1
Closed	> 20	> 1

A comparison between the cover classes of Edwards (1983), Gertenbach (1987) and of this study is given in Table 3.2.

3.6.4 Primary growth form

Edwards (1983) used four types of growth forms that determine the essential spatial geometry of vegetation, viz. trees, shrubs, grasses and herbs. Gertenbach (1987) used the following growth forms, viz. fieldlayer - including grasses and non-graslike herbs, shrubs (high- and low stratum) and trees. For the purpose of this study only three layers were used, viz. trees, shrubs and herbaceous layer.

3.6.5 Structure classes

The structural classification used for this study consists of the following cover classes, viz. closed, open and sparse (Table 3.2) and the following height classes, viz. tree (>3 m), shrub (>1 - 3 m) and herbaceous (0 - 1 m) (Table 3.1).

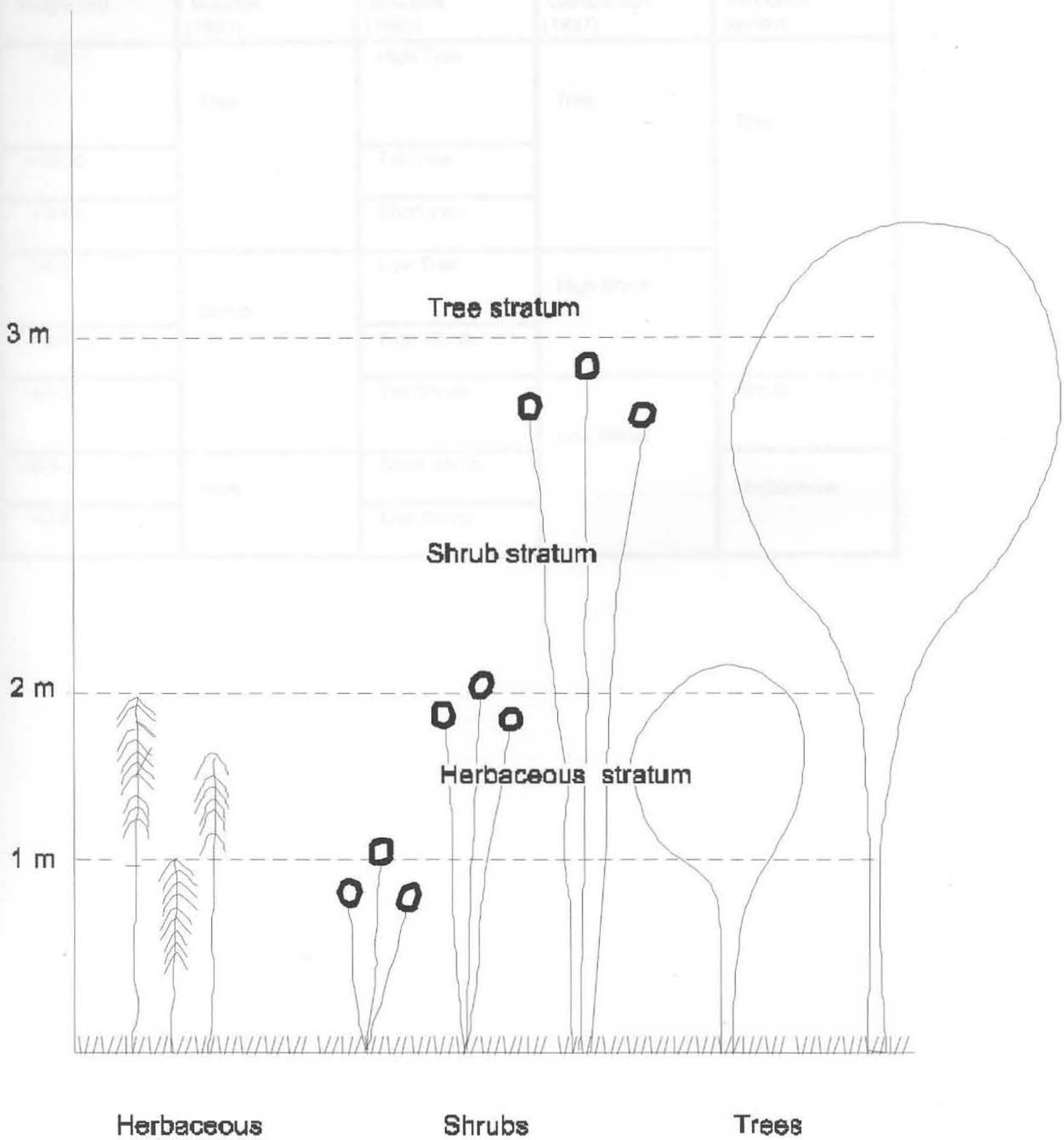

Figure 3.2 Diagramatic presentation of the different height classes for the vegetation of Marakele National Park.

Table 3.1 A comparison of height classes according to the systems of Westfall (1981), Edwards (1983), Gertenbach (1987) and the proposed system for this study.

<table>
<tr><th>Height (m)</th><th>Westfall, (1981)</th><th>Edwards, (1983)</th><th>Gertenbach, (1987)</th><th>Proposed System</th></tr>
<tr><td>>20</td><td rowspan="3">Tree</td><td>High Tree</td><td rowspan="3">Tree</td><td rowspan="5">Tree</td></tr>
<tr><td>>10-20</td><td>Tall Tree</td></tr>
<tr><td>>5-10</td><td>Short tree</td></tr>
<tr><td>>4-5</td><td rowspan="3">Shrub</td><td>Low Tree</td><td rowspan="2">High Shrub</td></tr>
<tr><td>>2-4</td><td>High Shrub</td></tr>
<tr><td>>1-3</td><td>Tall Shrub</td><td rowspan="3">Low Shrub</td><td>Shrub</td></tr>
<tr><td>>0,5-2</td><td rowspan="2">Herb</td><td>Short Shrub</td><td rowspan="2">Herbaceous</td></tr>
<tr><td><0,5</td><td>Low Shrub</td></tr>
</table>

Table 3.2 A comparison of the cover classes of the structural classification systems of Edwards (1983), Gertenbach (1987) and the proposed system of this study.

<table>
<tr><th>% Cover</th><th>Crown: Gap</th><th>Edwards, (1983)</th><th>Gertenbach, (1987)</th><th>Proposed System</th></tr>
<tr><td>> 75 – 100</td><td rowspan="4">0 - 1</td><td rowspan="6">Closed</td><td rowspan="4">Dense</td><td rowspan="6">Closed</td></tr>
<tr><td>> 60 - 75</td></tr>
<tr><td>> 25 - 60</td></tr>
<tr><td>> 20 - 25</td></tr>
<tr><td>> 15 - 20</td><td rowspan="2">< 2 - 1</td><td rowspan="2">Moderate</td></tr>
<tr><td>> 10 - 15</td></tr>
<tr><td>> 5 - 10</td><td>< 3,3 - 2</td><td rowspan="2">Open</td><td>Open</td><td rowspan="2">Open</td></tr>
<tr><td>> 1 - 5</td><td>< 8,5 - 3,3</td><td rowspan="3">Sparse</td></tr>
<tr><td><0,1 - 1</td><td rowspan="2">> 30 - 8,5</td><td>Sparse</td><td rowspan="2">Sparse</td></tr>
<tr><td><0,1</td><td>Scattered</td></tr>
</table>

3.7 HABITAT DATA

3.7.1 Introduction

It is not always the aim of casual-analytical vegetation research to study the reaction of plants to individual site factors, but to analyse their reaction to the combination of all factors. In particular, it is important to recognize the factors that are primarily responsible for the control of the species combination of the plant community under study (Mueller-Dombois & Ellenberg 1974). The following habitat information was recorded at each sample plot:

3.7.2 Terrain morphology

The terrain morphological classes where each sample plot is situated, was recorded. The following classes were used (Gertenbach 1987):

Symbol	Class
A	Summit
B	Plateau
CF	Cliff face
D	Upper slope
E	Lower slope
H	Steep bank / kloof
V	Valley floor

3.7.3 Altitude

The altitude of each sample plot was recorded using an altimeter and is given in metres (Table 4.2).

3.7.4 Slope

The slope of the terrain of each sample plot was measured in degrees, using an optical clinometer (Table 4.2). The following classification of slope units (Westfall 1981), were used in this study:

Symbol	Description	Class
L	level	0,00° - 3,49°
G	gentle	3,50° - 17,62°
M	moderate	17,63°- 36,39°
S	steep	36,40°

3.7.5 Aspect

The aspect of the terrain where each sample plot is situated was determined using a compass. Aspect is given in the eight compass directions (Table 4.2), namely:

N - North	**S** - South
NE - Northeast	**SW** - Southwest
E - East	**W** - West
SE - Southeast	**NW** - Northwest

3.7.6 Surface rock cover

The surface rock cover in each sample plot was estimated as a percentage stones (larger than 20 mm diameter), boulders and rocky outcrops. The following five classes (Table 4.2) were used, based on its potential influence on mechanical use (ploughing) (Van der Meulen 1979; Westfall 1981):

Symbol	**Class**	**Description**
O	< 1 %	No limitation on mechanical utilization
L	1 - 4 %	Low limitation on mechanical utilization
M	5 - 34 %	Moderate limitation on mechanical utilization

H	35 - 84 %	High limitation on mechanical utilization
V	5 - 100 %	No mechanical utilization possible

3.8 DATA PROCESSING

A first approximation of the vegetation classification was obtained by the application of the Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979). Using Braun-Blanquet procedures the result was further refined by the procedure described by Bezuidenhout et al. (1996). The results are presented in a phytosociological table and a synoptic table.

3.9 RANGE CONDITION

Veld management can be described as the science that deals with the utilization and conservation of the natural veld to improve maximal animal production, without being prejudicial to the vegetation. The quality and production of the vegetation must thus be maintained or be improved (Bredenkamp & Van Rooyen 1991 a&b, Barnes 1992).

The planning of veld management in this study depends upon thorough knowledge of the vegetation, the fluctuation of the vegetation, plant succession, carrying capacity (stocking rate) and the quality of the veld and the reaction of the vegetation to grazing, fire, bush clearing and other practices.

Veld condition refers to the condition of the vegetation in relation to some functional characteristics, normally sustained forage production and resistance of the veld to soil erosion (Trollope et al. 1989). The assessing of veld condition has proven very valuable for formulating veld management practices like stocking rate, rotational grazing, rotational resting and veld burning (Trollope et al. 1989).

The vegetation of the study area is representative of Acocks's (1988) North-Eastern Mountain Sourveld (Veld Type 8), Mixed Bushveld (Veld Type 18), Sourish Mixed Bushveld (Veld Type 19) and Sour Bushveld (Veld Type 20), thus, the grazing was from a sweet to sourveld. In the past the study area was utilised for cattle farming and where no veld management had been applied, the sweet veld was often heavily overgrazed, which led to bush encroachment and weakening of the veld. Drought has also lead to the retrogression of the veld (Bredenkamp & Van Rooyen 1991 a&b).

In the phytosociological classification 16 different plant communities were identified (see Chapter 4) and each of these plant communities are found in different habitats with different species composition and therefore having its own grazing capacity and stocking rate. The different plant communities also represent specific habitats for certain game species that might have an influence on the stocking rate of the different game species for MNP.

The veld condition and grazing capacity will fluctuate from season to season depending on drought and the amount and period of rainfall and the present stocking rate (Bredenkamp & Van Rooyen 1991 a&b).

In this study the present grazing capacity of 10 plant communities, which include four variations was determined. The grazing capacity of the following plant communities was not determined because of the small size, low grazing potential and/or inaccessibility of the communities (Table 4.1):

Widdringtonia nodiflora-Podocarpus latifolius Short Forest.
Podocarpus latifolius-Rothmannia capensis Tall Forest.
Buxus macowanii-Kirkia wilmsii Low Forest.
Rhus leptodictya-Mimusops zeyheri Termitarium Thickets.
Olea europaea-Calpurnia aurea Tall Closed Woodland.
Syzygium cordatum-Miscanthus junceus Short Thicket.

The different grass species and forbs (non grassy herbaceous plants) that were recorded by the point surveys in the different plant communities were arranged by virtue of their % frequency. The grass species and other forbs were categorized by virtue of their palatibility, grazing potential and reaction upon grazing (Bredenkamp & Van Rooyen 1991 a&b):

D = **Decreaser species**: grass and other herbaceous species that tend to decrease when the veld is under or overutilised;

I1 = **Increaser 1 species**: grass and other herbaceous species that tend to increase when the veld is underutilised;

I2a&b = **Increaser 2a&b species**: grass and other herbaceous species that tend to increase when the veld is selectively overutilised;

I2c = **Increaser 2c species**: grass and other herbaceous species that tend to increase when the veld is heavily overutilised and/or disturbed (Trollope et al. 1989).

With the aid of the above-mentioned categories an ecological index of veld condition was determined. The maximum theoretical index value which could be obtained is 1 000, for example if all the grass species were Decreasers (constant scale of 10 = Decreasers; 7 = Increaser 1; 4 = Increaser 2a&b and 1 = Increaser 2c). Veld in good condition with a high grazing capacity has a high percentage Decreaser and Increaser 1 grass species composition. The grazing capacity is calculated from the ecological index, grass cover, degree of bush, rainfall and fire regimé (Bredenkamp & Van Rooyen 1991 a&b).

The grazing capacity of the study area was determined for:

* the veld in present condition, with the average rainfall of 556 mm per annum (see Chapter 2),
* a year with below average rainfall (23 % or 429 mm per annum) (see Chapter 2).

With the calculation of grazing capacity for game species, the availability of leaves, habitat characteristics (for example hills, plains and rivers) as well as the selective grazing habits of many game species were considered.